Basic Information on WUS Seismic-Hazard Input Files

The input files for WUS seismic-hazard sources, omitting Cascadia subduction and most California sources, are found in this folder or subdirectory. Two zip files are included, one corresponding to WUS background or gridded sources, and the other corresponding to WUS fault sources.

Most of the gridded hazard source input files, found in WUSmap.zip, may be run with the program hazgridXnga4.f once it has been compiled. There are two types of gridded WUS sources, crustal sources and deep intraplate sources. The latter sources are in three input files, CAdeep.in, portdeep.in, and pacnwdeep.in – these can be run with hazgridXnga3. The crustal-source input files correspond to different regions or different logic-tree treatments of the same region (Pugetmap for example). There are always two input files for a given crustal source region, the C and the G files. The C file is associated with the characteristic fault logic-tree branches, and the G file is associated with the Gutenberg-Richter logic-tree branches. The differences are in the Mmax (maximum gridded-source magnitude) files that are associated with these input files. Mmax can be larger for the C file sources in the vicinity of faults with characteristic M > 6.5. The deep source files do not have the C, G pairs because these sources are in a sub-crustal region where faults have not been mapped. All of the gridded-source input files must read in one, two, or three files of geographically varying information. These grid files are included in a subdirectory GR_DOS. The user must modify input file path names to look in this GR_DOS folder or subdirectory (or rename it to whatever you wish). The fortran code will look where you tell it to look for these files. These gridded files are written for Windows machines, not for Solaris. A cshell script called run.wusmap for running the gridded or map hazard is included in the zip file.

The fault source files, found in WUSfaults.zip, may all be run with the program hazFXnga7c.f once it has been compiled. In the 2008 update, many uncertainties related to fault properties have been included in the model. Some of these uncertainties show up as different input files. For example, in the Basin and Range of the WUS, normal-slip faults have three logic-tree branches for fault-dip uncertainty. The maximum-weight branch has default fault dip of 50°, and the lower-weight alternate branches have fault dips of 40° and 60°, respectively (a few Basin and Range normal faults have slightly different dip distributions). File names with d40, 40d, d60, or 60d in them are associated with these alternate fault-dip models. There are usually characteristic-rupture files (char files) and alternate truncated Gutenberg-Richter files (GR files). For faults with Mmax ≤6.5, only characteristic rupture is modeled. Strike-slip faults tend to have vertical dip with no dip uncertainty. The orwa_c files correspond to faults in a compressional or transpressional stress regime of western Washington and Oregon. The non-vertical dipping faults described in these files have just one dip (usually 60°). A run.WUSfaults cshell script that shows the runs associated with WUS fault hazard is included in the fault zip file.

October 24, 2008: The Utah files associated with earthquakes with M6.5 and less were eliminated and replaced with one file, ut-65-granger.9dip. This file should be used with full weight and the other "ut-65" files should be removed from the WUS fault hazard analysis.

California Seismic Hazard Input Files for 2008 USGS PSHA

The California portion of the hazard input files has been put into two zip files, CA_faults.zip and CA_map.zip. The former zip file contains all of the California fault-source model input files, and the latter zip file contains the all of the California gridded-seismicity (background) model input files, along with associated input grid files. Those input grid files are in a subdirectory or subfolder called GR_DOS. The DOS designation is important. These are binary files with the –endian form appropriate for Windows and other PCs. These binary input files are not appropriate for Solaris-machine runs until they are converted using a program like swapf.c.

The fault files may be run with hazFXnga7c.f once it is compiled. The gridded files can be run with hazgridXnga3.f or with hazgridXnga4.f, as appropriate. HazgridXnga4 uses a slightly more accurate distance discretization than hazgridXnga3 for finding the distance from an unknown fault of unspecified orientation but with known fault center and known M. See the run.CAmap cshell script for which is appropriate. Some of the gridded source regions in this zip file extend outside of California, into Nevada, Arizona, and Mexico. Similarly, some of the non-California gridded source regions extend into California, for example WUSmapC and EXTmapC. To obtain a complete seismic-hazard model for California, several of the other WUS files must be run. Cascadia subduction is an important hazard contributor in northwest California.

Once all of the California source models have been run, the output files are combined with the other WUS source output files. The weights that we apply to these files and other details are contained in the folder on combining WUS seismic hazard. Several readme files discuss some of the details associated with this important topic.

Basic Information on CEUS Seismic-Hazard Input Files

The CEUS zip file, CEUS.map.input.zip, contains the input ascii files and binary files that are required for running hazgridXnga2 for background sources in the central and eastern US (CEUS). The binary files which are included in this zip file were written for a Windows or similar operating system. They will not work on a Solaris system. Users will have to modify folder or subdirectory names to their specific needs. The equivalent Solaris-system binary files can be created by a simple byte-swap process.

A cshell script, run.ceus.2007, shows the various runs that are required to compute the background source hazard using the 2008 USGS seismic-hazard model. The Fortran 95 code hazgridXnga2.f is also included here. A companion zip files, CEUSchar.zip, contains the files for running the Charleston, S.C. characteristic source models. HazgridXnga2.f is the program to use for both Charleston, S.C., and all background sources in the CEUS.

A second companion zip file, CEUS.faults.zip, contains the input fault files for the New Madrid Seismic Zone and for the Cheraw and Meers faults. These files are run with the program hazFXnga7c.f.

The zipped cshell scripts may work on Linux systems but will not work in typical Windows environments. However, the information contained in the script should help users to understand how the CEUS model was put together, i.e., all of the components. The scripts were originally written for SUN computers with Solaris Operating System. Brand names are for descriptive purposes only and do not constitute endorsement.

Once all of the CEUS source models have been run, the various output files from these runs must be combined. They can be combined to yield output curves or uniform hazard estimates at a grid of locations. The input files all define a grid of sites which covers much of the CEUS, 115 d W to 65 d W, and 24.6 d N to 50 d N. Sampling is uniform in 0.1 degree increments in latitude and longitude. The user can choose any rectangular grid of sites, but all input files must define the same grid if you wish to combine output files. The zip file CEUS.combine.zip contains the program hazallXL.v2.f and the input files that are used to combine these binary files. The cshell script, combine.ceusmap.csh, is run to get the uniform hazard values for the 2% in 50 year or 10% in 50 year Probability of Exceedance (PE). The companion script, combine.ceush.csh, is run to compute a binary hazard curve at each site in the grid. The resulting hazard curves for the CEUS are combined with a set of hazard curves for the WUS to get a set of US hazard curves. The merging of west and east is another step in the process. If you do not proceed with this next step of combining CEUS with WUS hazard curves, the CEUS hazard west of about 105 d W will be incomplete. However, you can safely make maps with western edge at 105 d W or less and have a complete CEUS hazard model in that region without also running the WUS hazard model.

Combining Seismic Hazard Files
Part I: WUS Background Sources

When the background or gridded hazard has been run for the WUS sources, the binary output files need to be combined with appropriate weights. These combine steps are performed in the script combine.grid.csh. This script runs the program hazallXL.v2.f several times. The input files to hazallXL.v2.f have to be binary files. For these background sources, the programs that write the input files to hazallXL.v2.f are hazgridXnga2.f and hazgridXnga3.f. These programs will write binary files if the first line of their input files has a 0 (zero) as the first field. This 0 is an instruction to perform calculations on a rectangular grid of sites and to write the results as a binary file. If this first field is greater than zero, the output files are ascii, and they cannot be combined with hazallXL.v2.f. The zip file combine.WUSgrid.zip contains all of the scripts and input files for Part I.

In order to combine various files successfully, several features of these files must be compatible. One obvious compatibility requirement is that the same grid of sites must have been considered. This grid does not have to cover the entire western United States, as in the attached input files, but does have to be the same region among all of the input files. Another requirement is that the same set of ground motions must have been sampled for each input file. A geotechnical requirement is that the same site condition must hold for each input file. Although this geotechnical requirement is important to honor, if the files do not have the same Vs30, the only consequence will be a warning message. It is always the user's responsibility to insure that the data being combined are fully compatible. The program hazallXL.v2.f will help him or her with this, but it does not and cannot check all possible compatibility issues.

There are some options in the cshell script, which was written for a Solaris operating system. One available option is to omit the deep background sources and only consider crustal source hazard. This option is invoked by entering the word "crustal" as argument 1 on the command line. If no arguments are included on command line, then all of the files corresponding to three spectral periods are expected to be available: PGA, 1-s SA, and 0.2-s SA. If any of these files are missing, an error message will be written and the combine process will not proceed. For the 2007-2008 USGS PSHA, there are typically 26 files per "run" in each gridded-source combine step, three of which correspond to deep-source hazard.

Another step in the background-source combine script is to interpolate the output files to a finer spatial sampling. For the WUS files, the original sampling is 0.1° in latitude and longitude, and the interpolation is to 0.05°. The output files of this step have "05" in their names to indicate that this interpolation step has taken place. A header record also contains this important information.

Combining Seismic Hazard Files
Part II: WUS Fault Sources

Once the background or gridded hazard for the WUS sources have been combined (see the Part I readme), the binary output files need to be combined with fault source files. The fault-source hazard files are typically sampled at 0.05 degrees in latitude and longitude. These combine steps are performed in two scripts, hazall.wus.csh and combine.2008h.csh. These scripts also run the program hazallXL.v2.f several times. As stated in the Part I readme, the input files to hazallXL.v2.f have to be binary files. The scripts and associated input files are found in the zip file combine.wushazard.zip.

The WUS fault-source combine is performed in two steps. The first step combines files associated with a given branch of ground-motion uncertainty. There are three such branches, a central branch, an upper-gm branch, where files have a .p extension, and a lower-gm branch, where files have a .m extension. The central branch files have no such extension, and their names typically end stating the ground motion, e.g., pga, 1hz, or 5hz. WUS background source contributions and Cascadia source contributions are also combined in this first step.

The second step, which uses combine.2008h.csh, combines the three ground-motion uncertainty branches into a single mean seismic hazard curve at each site. The various input files associated with combining hazard for PGA, 1-s SA, and 0.2-s SA have been included in the zip file. Some sample combine files that yield the 2% PE in 50 year ground motion estimates are also included. These can be easily modified to output the ground motion corresponding to any other probability of exceeedance. These values are often called "uniform hazard" values because they are spatially invariant with respect to probability of the indicated ground motion being exceeded in a given time interval. The uniform hazard ground motions at this step will be valid for the westernmost part of the grid region, for example Washington, Oregon, California, and so on.

There is a final step to perform, which is the combining of the WUS with CEUS hazard curves. This step is important in a broad region where WUS and CEUS have some overlapping hazard contributions. Some states where CEUS and WUS contributions overlap significantly are Montana, Wyoming, Colorado, New Mexico and Texas. This step is further discussed in Part III.

Combining Seismic Hazard Files
Part III: CEUS and WUS Sources

Combining of the WUS with CEUS hazard curves is discussed in this readme. This step is important in a broad region where WUS and CEUS have some overlapping hazard contributions. Some states where CEUS and WUS contributions overlap significantly are Montana, Wyoming, Colorado, New Mexico and Texas. The final hazard curves and uniform hazard arrays that are posted on the web are the results of steps summarized in the cshell scripts contained in combine.UShazard.zip.

All WUS hazard models were either computed at a spatial increment of 0.05 degrees or were interpolated to that sampling interval. The CEUS hazard model was computed at 0.10 degrees spatial sampling. The two programs that are run in the scripts associated with this step deal with the different spatial sampling and the different region boundaries. The CEUS western grid boundary for purposes of hazard calculation is at 115° W, and the WUS eastern boundary is at 100° W longitude. Thus, hazard curves in the overlap region, 115° to 100°, must be combined to get a full model of seismic hazard in that region.

The programs that are used to perform the combining of CEUS and WUS hazard curves were designed to run on SUN computers with Solaris operating system. These programs are combineL.v2.f and combinehaz2007.f. They are included in this Zip file, but we have not tested them on PCs or other computers. Thus, we have no experience with this step when performed on PCs. Also, a cursory examination of these programs will show you that they are designed to merge data with very specific region boundaries. The WUS region is -125 to -100 degrees E and 24.6 to 50 degrees N, and the CEUS region is -115 to -65 degrees E and 24.6 to 50 degrees N.
Any deviation from these regions is expected to produce unacceptable results. However, it would be easy to modify the codes to work with more flexibly defined regions.

In contrast to the programs combineL.v2.f and combinehaz2007.f, all other programs for PSHA that we include at this web site have been tested on PCs and PC clusters. The tests include comparing output from PC Windows runs with that from Sun Solaris runs. The gnu-fortran compiler (March 2008) and Intel compiler, ifort, were used in these cross-platform comparisons. Such tests have not yet been performed for combineL.v2.f and combinehaz2007.f. Product names are for descriptive purposes only and do not constitute endorsement by USGS.